A Hierarchical IP Addressing Scheme for Mobile Ad-hoc Networks

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Outline

- Ad-hoc Networks.
- Auto-Configuration.
- Addressing & Routing
- Inter-Networking.
- Geographic IP Addressing (GIPA).
- Simulation Results.

Ad-hoc Networks

- Self organized nodes forming a spontaneous network.
- Nodes can leave or join the network at any time.
- Lack of central configuration entities e.g. DHCP.
- Nodes need to be self configured with valid IP addresses for inter-MANET communications.
- Hierarchical IP addressing is a desired feature for scalability and MANET communication with legacy IP networks.

Auto-Configuration

- Auto-Configuration should be dynamic to support mobility.
- Need to detect nodes mobility when joining a different MANET subnet.
- Should take place each time a node visits a new MANET subnet.

Addressing & Routing

- Hierarchical addressing is needed for hierarchical routing.
- Need to be IP based for MANET to communicate with legacy IP networks.
- Each node in a given geographic area should have the same subnet id and unique host id.
- Hierarchical IP routing for inter-MANET communications.
- Flat IP routing for intra-MANET communications.

Inter-Networking

- MANETs need to communicate with legacy IP fixed networks.
- Example 1:

  Aircraft in an airborne MANET network need to communication with the ground Air Traffic Control.
- Example 2:

  A rescue team forming a MANET network in a disaster area need to communicate with the disasters relief center network.

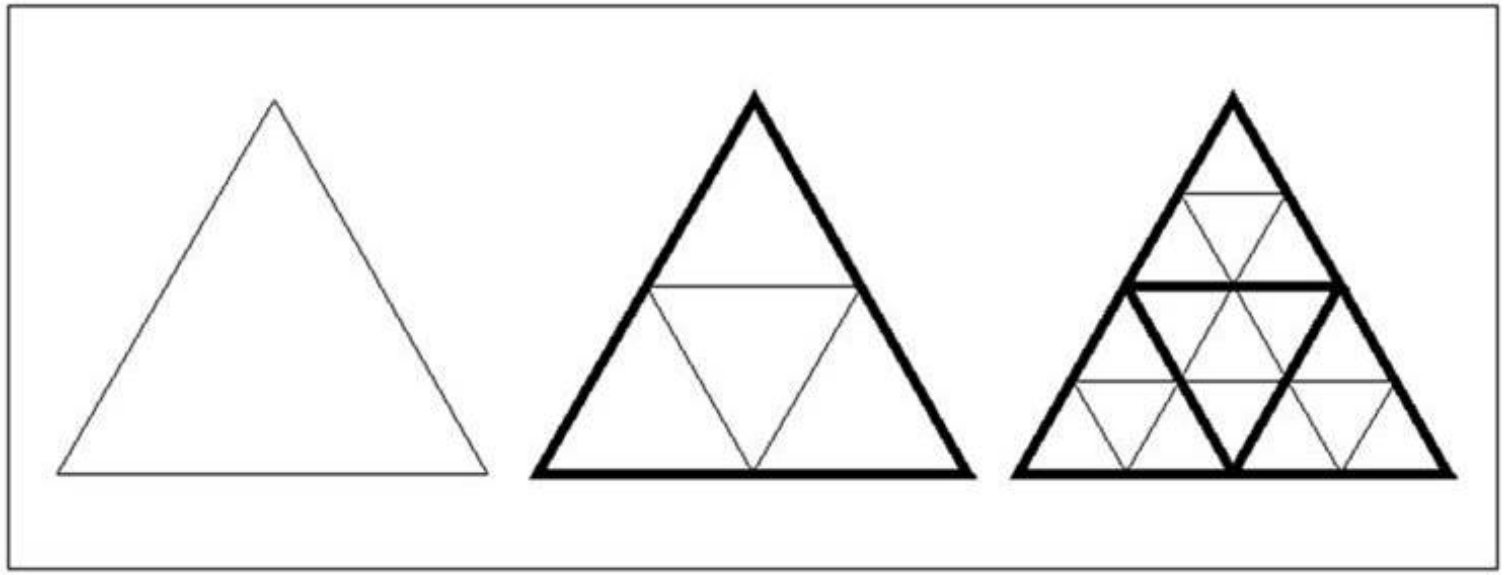
GIPA (1/7)

- Each node is equipped with a GPS receiver to obtain the node's geographical location.
- A geographical area is divided to zones, each with a unique id.
- Discrete Global Grid System is used to develop a triangular/hexagonal recursive subdivision.
- Subdivision starts with a single triangle face representing one quarter of a hemisphere.

GIPA (2/7)

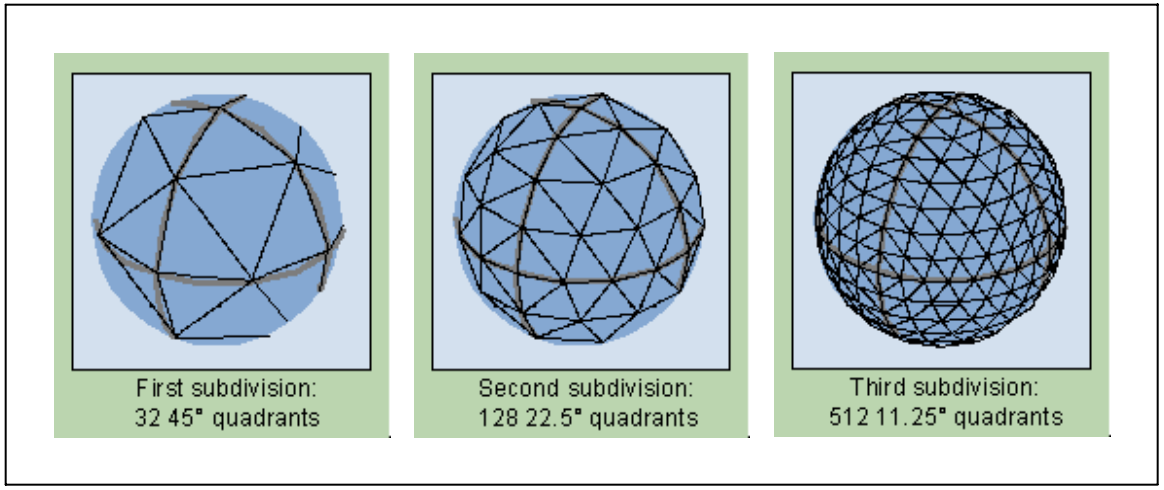
- Division could be global or sub-global based on applications needs.
- Zones ids are unique for global division and can be reused in sub-global division.
- The zone id is mapped to an index to access IP subnet database.
- The subdivision architecture allows the number of subnets to vary based on the application needs.

GIPA (3/7)



Three levels of aperture 4 triangle hierarchy defined on a single triangle

GIPA (4/7)



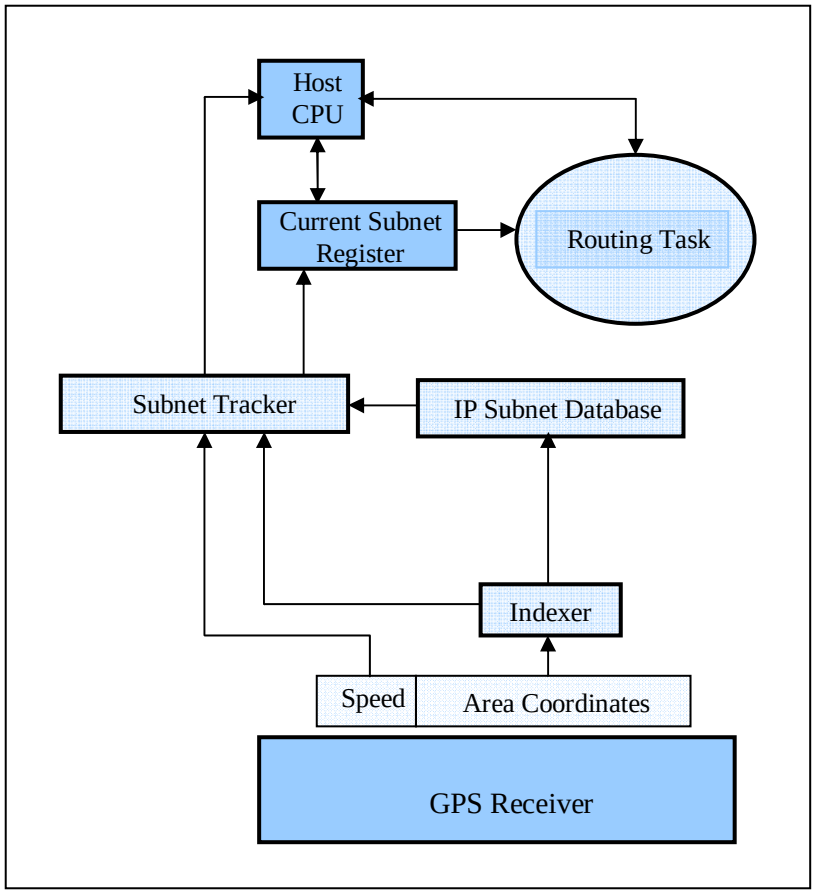
Hierarchical 1,2,3 subdivision of the earth surface modeled as octahedron

GIPA (5/7)

Resolution Level	Number of Zones	Zone Area (sq. km)	Number of Hosts/Zone	Comments
0	8	63,758,234.54	N/A	Earth area is 510,658,763 km^2
1	32	15,939,558.54	2,147,483,648	5 bits for subnets, 31 for hosts
2	128	3,984,889.659	536,870,912	7 bits for subnets, 29 for hosts
3	512	996,222.415	134,217,728	9 bits for subnets, 27 for hosts
4	2,0 84	249,055.604	33,554,432	11 bits for subnets, 25 for hosts
5	8,192	62,263.901	8,388,608	13 bits for subnets, 23 for hosts
6	32,768	15,565.975	2,097,152	15 bits for subnets, 21 for hosts
7	131,072	3,891.494	524,288	17 bits for subnets, 19 for hosts
8	524,288	972.874	131,072	19 bits for subnets, 17 for hosts
9	2,097,152	243.218	32,768	21 bits for subnets, 15 for hosts
10	8,388,608	60.805	8,192	23 bits for subnets, 13 for hosts
11	33,554,432	15.201	2,048	25 bits for subnets, 11 for hosts
12	134,217,728	3.800	512	27 bits for subnets, 9 for hosts

Zones count, size, and number of hosts at different partitioning resolutions

GIPA (6/7)

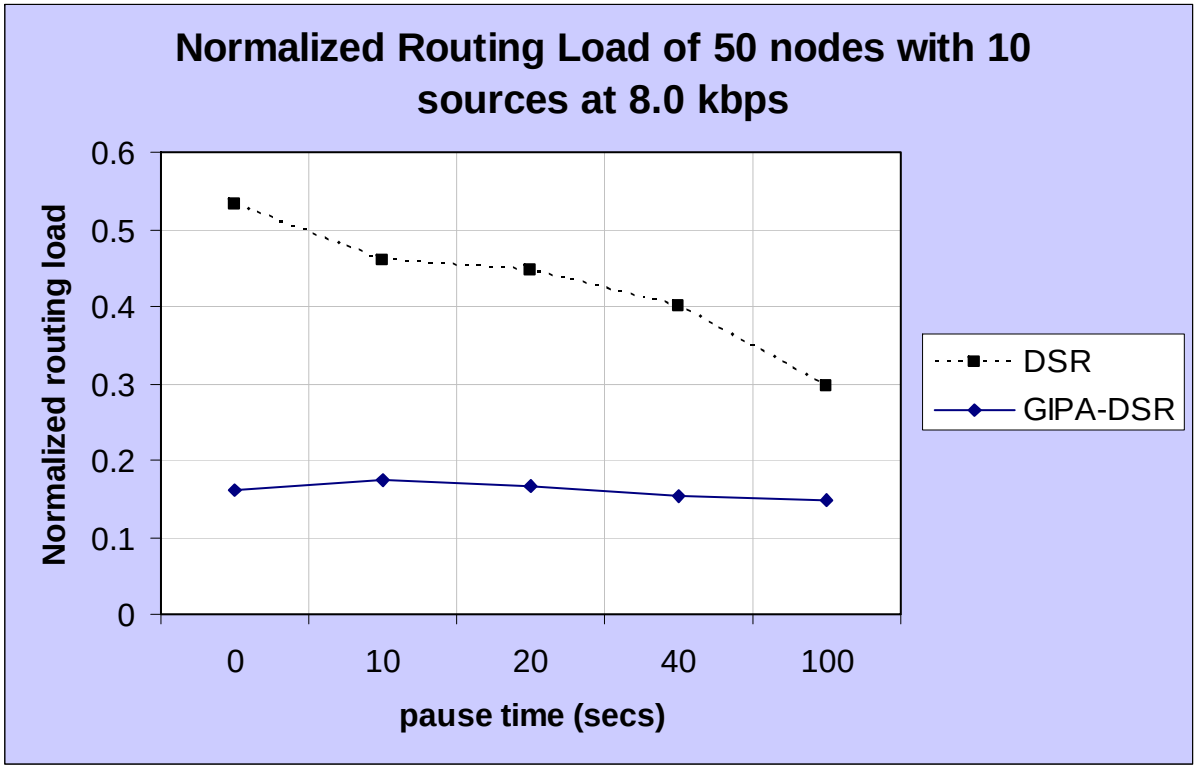


GIPA architecture and functions modules

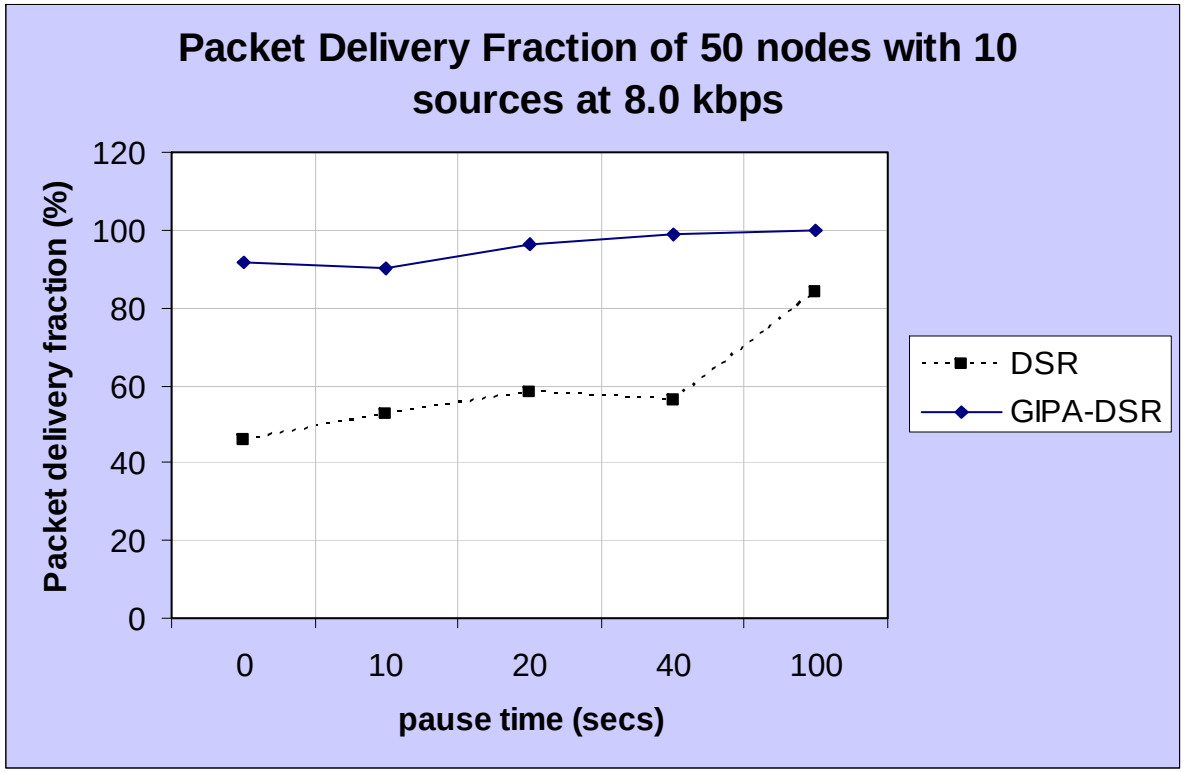
GIPA (7/7)

- GIPA provides the hierarchical addressing needed to achieve MANET scalability.
- GIPA allows IP communications between two different MANET subnets.
- GIPA allows IP communications between MANET and legacy IP network (Intranet, Internet).
- GIPA solves the problem of detecting the mobile node mobility.
- GIPA eliminates Mobile IP Foreign Agent overhead.

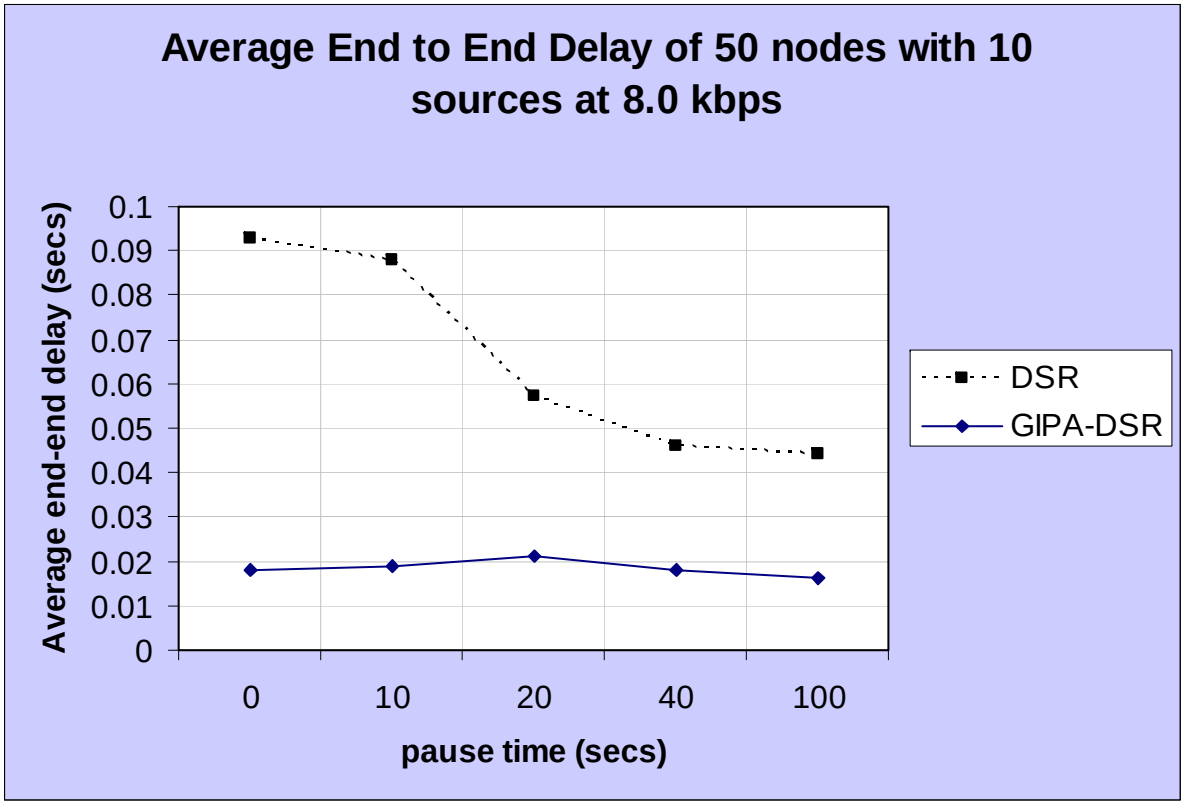
Simulation (1/3)



Simulation (2/3)



Simulation (3/3)



Questions

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